SURFACE WATER QUALITY GUIDELINES FOR USE IN ALBERTA

NOVEMBER 1999

Environmental Service
Environmental Sciences Division

Natural Resources Service
Water Management Division

Pub. No.: T/483
ISBN: 0-7785-0897-8

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GLOSSARY OF TERMS AND ACRONYMS

µg	Microgram.
Acute Guidelines	Alberta acute guidelines are equal to one-half the Final Acute Value. The Final Acute Value is an estimate of the concentration of the toxicant corresponding to a cumulative probability of 0.05 of the acute values of all genera for which acceptable acute tests have been conducted. Acute guidelines require an averaging period.
Acute Toxicity	Toxicity that is expressed over a short time period relative to the lifespan of the organism, usually a few minutes or days. The measurement endpoint is often related to mortality (LC_{50}).
AENV	Alberta Environment.
AEP	Alberta Environmental Protection (now AENV).
CCC	The Criterion Continuous Concentration (CCC) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect. (USEPA 1999)
CCME	Canadian Council of Ministers of the Environment.
CCREM	Canadian Council of Resource and Environment Ministers (now CCME).
CEQG	Canadian Environmental Quality Guidelines. Issued by CCME (1999), these contain the Canadian Water Quality Guidelines as well as other guidelines.
Chronic Guidelines	Alberta chronic guidelines are equal to the lowest of the Final Chronic Value or the Final Plant Value, unless other data show that a lower value should be used. The Final Plant Value is an appropriate measure of acute toxicity tests to plants. The final plant value is obtained by selecting the lowest result from a test in which the concentrations of test material were measured and the endpoint was biologically important.
Chronic Toxicity	Toxicity that is expressed over a longer time period and incorporates the organism's long term response to a toxicant. The measurement endpoint is often related to effects on growth or reproduction.
CMC	The Criteria Maximum Concentration (CMC) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. (USEPA 1999)
Continuous Guidelines	The full term for this is 'Criteria Continuous Concentration or CCC'.
Criteria	Represent a constituent concentration or level associated with a degree of environmental effect upon which scientific judgement may be based. (CCME) (Note that other agencies, such as the USEPA and British Columbia Ministry of Environment, Lands, and Parks, use this term to mean a guideline).
CWQG	Canadian Water Quality Guidelines.

EPEA	*Environmental Protection and Enhancement Act* (Alberta).
FAV	Final Acute Value. An estimate of the concentration of the toxicant corresponding to a cumulative probability of 0.05 in the acute values of all genera for which acceptable acute tests have been conducted.
FCV	Final Chronic Value. An estimation of the concentration of the toxicant corresponding to geometric means of a No Observed Effects Concentration (NOEC) and the Lowest Observed Effects Concentration (LOEC).
FPV	Final Plant Value. The final plant value is obtained by selecting the lowest result from a test in which the concentrations of test material were measured and the endpoint was biologically important.
Guidelines	Numerical concentration or narrative statements recommended to support and maintain a designated water use.
Interim	Tentative, or temporary. In deriving Canadian water quality guidelines for aquatic life, all components of the aquatic ecosystem (*e.g.*, algae, macrophytes, invertebrates, fish) are considered if the data are available. Where data are available but limited, interim guidelines are deemed preferable to no guidelines. In cases where there is insufficient information, an interim guideline is derived providing that a less stringent minimum data set is available. CCME Interim values are shaded in the guidelines tables.
L	Litre.
LC_{50}	The concentration (Lethal Concentration) of a substance that causes mortality to 50% of the test organisms.
Maximum Guidelines	The full term for this is 'Criteria Maximum Concentration or CMC'.
mg	Milligram.
mL	Millilitre.
nm	Nanometre.
NTU	Nephelometric Turbidity Unit.
Objectives	Numerical concentration or narrative statements established to support and protect the designated uses of water at a specified site (sometimes also referred to as 'reach-specific guidelines').
PAH	Polycyclic Aromatic Hydrocarbon.
Standards	Objectives that are recognized in enforceable environmental control laws of a level of government.
USEPA	United States Environmental Protection Agency.

1.0 INTRODUCTION

This document compiles surface water quality guidelines for use in Alberta. It updates and replaces the *Alberta Surface Water Quality Guidelines: A Working Compendium* of July 1998 (AEP 1998a) and is the latest edition in an ongoing process of development, review, and compilation of water quality guidelines. It also replaces Appendix 8 of the *Water Quality Based Effluent Limits Procedure Manual* (AEP 1995) and Section 3 of *A Comparison of Alberta's Environmental Standards to those of Other North American Jurisdictions* (AEP 1999).

One of the first major steps in the development of water quality guidelines for Alberta was the establishment of *the Alberta Surface Water Quality Objectives* in 1977 (AENV 1977). These objectives were the main values used to evaluate water quality until 1987, when the Canadian Council of Resource and Environment Ministers (CCREM) released the *Canadian Water Quality Guidelines* (CCREM 1987). Since then, the *Canadian Water Quality Guidelines* (CWQG) have been updated and guidelines for new substances have been added. The CWQG have also been used in Alberta, especially for substances without Alberta objectives, or where guidelines for a specific use have been required. In 1993, AEP re-issued its 1977 objectives, as interim guidelines (AEP 1993).

The *Alberta Environmental Protection and Enhancement Act* (EPEA), passed in 1993, provides for the development of guidelines and ambient environmental quality objectives for the province of Alberta. In accordance with this, the department established a protocol for developing water quality guidelines for the protection of freshwater aquatic life (AEP 1996a), which was used to prepare guidelines for selected substances (AEP 1996b; 1997; 1998b). The protocol was patterned on United States Environmental Protection Agency (USEPA) methods. In 1998, AEP compiled water quality guidelines in a new working compendium (AEP 1998a), based on the protocol document and drawing on Alberta, USEPA, and CCME guidelines and criteria. Recently, the USEPA has updated a number of their criteria and procedures (USEPA 1999) and CCME has released a new compilation of environmental quality guidelines (CCME 1999). This has prompted further review of guidelines suitable for use in Alberta.

Development and evaluation of water quality guidelines is an ongoing process and this document will be revised periodically to incorporate new information and guidelines. Users of this update are invited to provide comments or information to the Environmental Sciences Division, AENV, for consideration during the periodic reviews.

2.0 SURFACE WATER QUALITY GUIDELINES

This document supercedes the *Alberta Surface Water Quality Guidelines: A Working Compendium* of 1998 (AEP 1998a). It includes surface water quality guidelines for use in Alberta for the following:

- Protection of aquatic life (Table 1.0, 1.1, 1.2, and 1.3)
- Agriculture (Table 2.0)
- Recreation and aesthetics (Table 3.0)

The guidelines are numerical concentrations or narrative statements recommended to support and maintain a designated water use. Guidelines are listed for various substances or conditions in the accompanying tables, in alphabetical order. The guidelines presented in the tables have been compiled from new and previous Alberta guidelines, from CCME guidelines, and from USEPA criteria. Different jurisdictions use differing types of scientific information and statistical

methods to develop guidelines for their particular needs, and periodically modify these methods. The toxicity to aquatic life of some of these substances is affected by water hardness or pH. For these substances, guideline values have been calculated for various levels of hardness and pH, and are included in Tables 1.1 and 1.2. The formulae for these calculations are also provided in the tables. Users are also encouraged to refer to the supporting documents, in particular CCME (1999) and USEPA (1999) for a more comprehensive understanding of the purpose, context and derivation of the respective guidelines.

3.0 APPLICATION

The water quality guidelines outlined in this document are meant to provide general guidance in evaluating surface water quality throughout Alberta. If a substance has not been listed in this document, the substance may still be of interest to Alberta; however, presently no Alberta, CCME, or USEPA guidelines are available for that substance. When necessary, such substances will be dealt with on a case-by-case basis.

The water quality guidelines in this document can be used in combination with water quality monitoring data to assess ambient conditions and to identify areas with existing or potential water quality concerns. If monitoring data do not exceed the guidelines, problems are unlikely. If the guidelines are exceeded, a detailed assessment might be required in order to determine the extent, cause, and potential adverse effects arising from the exceedance. Guidelines are sometimes exceeded due to natural causes, such as heavy run-off and extreme weather conditions.

The guidelines are also used in setting water quality based approval limits for wastewater discharges. In cases where more than one guideline value for a substance is included in the tables, the more stringent value should be used to develop wastewater limits, unless scientific justification can be provided for doing otherwise. Alberta guidelines developed after 1996 are given preference over CCME and USEPA guideline values. The surface water quality guidelines do not apply to drinking water. AENV has adopted the *Guidelines for Canadian Drinking Water Quality* (Health Canada 1996) for drinking water.

The acute (maximum) and chronic (continuous) guidelines in Table 1.0 are important when establishing limits based on water quality. If near-instantaneous dispersal of the effluent occurs, then guidelines would be applicable near the end-of- pipe. Otherwise, a defined mixing zone might be established and water quality guidelines should be met at the edge of the defined mixing zone. Setting water quality based limits allows, where necessary, a limited mixing zone within which instream guidelines may be exceeded. Such an exceedance area should be small enough so as not to interfere with beneficial uses. Limits should be established to ensure protection of the water body as a whole (chronic) and to limit acute lethality to organisms passing through the plume (acute). More details on developing effluent limits and the interpretation of frequency, magnitude and duration of guideline exceedances can be obtained from the *Water Quality Based Effluent Limits Procedures Manual* (AEP 1995).

AENV, in consultation with stakeholders, may wish to address specific substances and their effects in certain water bodies, in order to protect designated water uses and maintain the quality of ambient waters. In some cases, guidelines included in this document might be under- or over-protective because species at a given site might differ in sensitivity than those used for the development of the guideline. As well, characteristics of water at the site might alter the toxicity of the material. The *Water Act* allows for the development of objectives for specific water bodies in order to address such concerns. When necessary, water body specific objectives will be developed on a case-by-case basis.

TABLES

Notes on the Tables:

- Except where noted, all metals are in total recoverable form. Typically, CCME metal guidelines refer to total concentration in an unfiltered sample. Many, but not all, USEPA metal guidelines refer to the dissolved fraction in the water column.
- For more information on a particular substance, please refer to the CCME fact sheet (CCME 1999) or the USEPA reference material (USEPA 1999).
- Shaded values indicate CCME interim guidelines.

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TABLE 1.0 WATER QUALITY GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE

SUBSTANCE OR CONDITION	CATEGORY	UNIT	ALBERTA		CCME Shaded values are interim	USEPA	
			Acute	Chronic		Maximum Concentration	Continuous Concentration
Acenaphthene	Trace Organic (PAH)	µg/L			5.8		
Acridine	Trace Organic (PAH)	µg/L			4.4		
Aldicarb	Pesticide	µg/L			1		
Aldrin	Pesticide	µg/L			0.004[1, 2, 3]	3[4]	
Alkalinity (as $CaCO_3$)	Ions and General	mg/L					20[5]
Aluminum	Metal	µg/L			5 to 100[6]	750[7]	87[7, 8]
Ammonia	Nutrient	mg/L			1.37 to 2.20[9]	See Table 1.1	See Table 1.1
Aniline	Trace Organic	µg/L			2.2		
Anthracene	Trace Organic (PAH)	µg/L			0.012		
Arsenic (Total)	Metal	µg/L			5.0	340[10]	150[10]
Atrazine	Pesticide	µg/L			1.8		
Benz*(a)*anthracene	Trace Organic (PAH)	µg/L			0.018		
Benzo*(a)*pyrene	Trace Organic (PAH)	µg/L			0.015		
Benzene	Trace Organic	µg/L			370		
Bromacil	Pesticide	µg/L			5.0		

[1] CCME no longer recommends this guideline and has withdrawn the value. CCME does not recommend a water quality guideline. Environmental exposure is predominantly via sediment, soil, and/or tissue; therefore, the reader is referred to the respective CEQG guidelines for these media.

[2] This substance meets the criteria for a Track 1 substance under the national CCME Policy for the Management of Toxic Substances (PMTS) (i.e., persistent, bioaccumulative, primarily the result of human activity, and Canadian Environmental Protection Act-toxic or equivalent) and should be subject to virtual elimination strategies. Guidelines can serve as action levels or interim management objectives towards virtual elimination.

[3] CEQG for Aldrin applies to Aldrin+Dieldrin. CEQG guideline for Dieldrin applies to Aldrin+Dieldrin.

[4] USEPA Guideline based on aquatic life criterion issued in 1980. The minimum data requirements and derivation procedures were different in the 1980 USEPA guidelines than in the 1985 USEPA guidelines. For example, a CMC derived using the 1980 guideline was derived to be used as an instantaneous maximum. If assessment is to be done using an averaging period, the values given should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 guidelines.

[5] USEPA guideline for alkalinity is 20 mg/L or more as $CaCO_3$ except where natural conditions are less.

[6] CEQG guideline for aluminum = 5 µg/L at pH<6.5; $[Ca^{2+}]$<4 mg/L; DOC <2 mg/L
= 100 µg/L at pH ≥6.5; $[Ca^{2+}]$ ≥4 mg/L; DOC ≥2 mg/L.

[7] USEPA guideline for aluminum at pH 6.5 to 9.0. Guideline is for total recoverable metal in the water column.

[8] There are three major reasons why the use of Water-Effect Ratios might be appropriate. (1) The value of 87 µg/l is based on a toxicity test with the striped bass in water with pH= 6.5-6.6 and hardness < 10mg/L. Data in "Aluminum Water-Effect Ratio for the 3M Plant Effluent Discharge, Middleway, West Virgina" (May 1994) indicate that aluminum is substantially less toxic at higher pH and hardness, but the effects of pH and hardness are not well quantified at this time. (2) In tests with the brook trout at low pH and hardness, effects increased with increasing concentrations of total aluminum even though the concentration of dissolved aluminum was constant, indicating that total recoverable is a more appropriate measurement than dissolved, at least when particulate aluminum is primarily aluminum hydroxide particles. In surface waters, however, the total recoverable procedure might measure aluminum associated with clay particles, which might be less toxic than aluminum associated with aluminum hydroxide. (3) EPA is aware of field data indicating that many high quality waters in the U.S. contain more than 87 µg aluminum/L, when either total recoverable or dissolved is measured.

[9] CEQG guideline for ammonia: 1.37 mg/L at pH 8.0, 10°C; 2.20 mg/L at pH 6.5, 10°C.

[10] USEPA water quality criterion for arsenic was derived from data for arsenic (III) but is applied here to total arsenic (both arsenic V and arsenic III). The value is the same for both dissolved and total recoverable fractions of arsenic.

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			Acute	Chronic	Shaded values are interim	Maximum Concentration	Continuous Concentration
Bromoxynil	Pesticide	µg/L			5.0		
Cadmium	Metal	µg/L			See Table 1.2	See Table 1.2	See Table 1.2
Captan	Pesticide	µg/L			1.3		
Carbaryl	Pesticide	µg/L			0.20		
Carbofuran	Pesticide	µg/L			1.8		
Carbon tetrachloride (Tetrachloromethane)	Trace Organic	µg/L			13.3		
Chlordane	Pesticide	µg/L			0.006[1,2]	2.4[4]	0.0043[4]
Chloride	Ions and General	mg/L				860	230
Chlorine	Ions and General	µg/L			0.5[11]	19	11
Chloroform (Trichloromethane)	Trace Organic	µg/L			1.8		
Chlorophenol (mono)	Trace Organic	µg/L			7		
Chlorophenol (di)	Trace Organic	µg/L			0.2		
Chlorophenol (tri)	Trace Organic	µg/L			18		
Chlorophenol (tetra)	Trace Organic	µg/L			1		
Chlorophenol (penta) (PCP or Pentachlorophenol)	Trace Organic	µg/L			0.5	19[12]	15[13]
Chlorophenoxy herbicides (Also known as phenoxy herbicides)	Pesticide	µg/L			4.0		
Chlorothalonil	Pesticide	µg/L			0.18		
Chlorpyrifos	Pesticide	µg/L			0.0035	0.083	0.041
Chromium III	Metal	µg/L			8.9	See Table 1.2	See Table 1.2
Chromium VI	Metal	µg/L			1.0	16[14]	11[14]
Colour[15]	Physical		See narrative[16,17]		See narrative[18]		See narrative[19]

[11] CEQG guideline is for reactive chlorine species (hypochlorous acid and monochloroamine).
[12] USEPA maximum concentration pentachlorophenol freshwater aquatic life guideline is pH dependent. Value shown is for 7.8 pH units. Maximum Concentration = exp(1.005(pH)-4.869).
[13] USEPA continuous concentration pentachlorophenol freshwater aquatic life guideline is pH dependent. Value shown is for 7.8 pH units. Continuous Concentration = exp(1.005(pH)-5.134).
[14] USEPA guideline values for most metals are expressed in terms of the dissolved metal in the water column. To convert dissolved concentrations to total recoverable metal in the water column, the guidelines given can be divided by a conversion factor (CF). The CF for Chromium VI is 0.982 for the Maximum Concentration guideline and 0.962 for the Continuous Concentration guideline. The CF for Mercury is 0.85 for both Maximum and Continuous Concentrations.
[15] Although not directly toxic to freshwater aquatic life, these values are included due to their broader influence on conditions that affect aquatic life.
[16] Alberta colour guideline: Not to be increased more than 30 colour units above natural value.
[17] From AENV 1993. These values can be applied as chronic guidelines.
[18] CEQG Colour guideline: True colour - the mean absorbance at 456 nm of filtered water samples shall not be significantly greater than the seasonally adjusted expected value for the system under consideration. Apparent colour - the mean percent transmission of white light per metre shall not be significantly less than the seasonally adjusted expected value for the system under consideration.
[19] USEPA Colour guideline: Waters shall be virtually free from substances producing objectionable colour for aesthetic purposes Increased colour (in combination with turbidity) should not reduce the depth of the compensation point for photosynthetic activity by more than 10 % from the seasonally established norm for aquatic life.

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Chlordane	Pesticide	µg/L			0.006[1,2]	2.4[4]	0.0043[4]
Chloride	Ions and General	mg/L				860	230
Chlorine	Ions and General	µg/L			0.5[11]	19	11
Chloroform (Trichloromethane)	Trace Organic	µg/L			1.8		
Chlorophenol (mono)	Trace Organic	µg/L			7		
Chlorophenol (di)	Trace Organic	µg/L			0.2		
Chlorophenol (tri)	Trace Organic	µg/L			18		
Chlorophenol (tetra)	Trace Organic	µg/L			1		
Chlorophenol (penta) (PCP or Pentachlorophenol)	Trace Organic	µg/L			0.5	19[12]	15[13]
Chlorophenoxy herbicides (Also known as phenoxy herbicides)	Pesticide	µg/L			4.0		
Chlorothalonil	Pesticide	µg/L			0.18		
Chlorpyrifos	Pesticide	µg/L			0.0035	0.083	0.041
Chromium III	Metal	µg/L			8.9	See Table 1.2	See Table 1.2
Chromium VI	Metal	µg/L			1.0	16[14]	11[14]
Colour[15]	Physical		See narrative[16,17]		See narrative[18]		See narrative[19]

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			Acute	Chronic		Maximum Concentration	Continuous Concentration
Copper	Metal	µg/L	See Table 1.2	7[20]	2 to 4[21]	See Table 1.2	See Table 1.2
Cyanazine	Pesticide	µg/L			2.0		
Cyanide (as free CN)	Ions and General	µg/L			5	22	5.2
DDT (total) (Dichloro diphenyl trichloroethane)	Pesticide	µg/L			~~0.001~~[1,2]	1.1[4]	0.001[4]
Deltamethrin	Pesticide	µg/L			0.0004		
Demeton	Pesticide	µg/L					0.1
Dicamba	Pesticide	µg/L			10		
Diclofop-methyl	Pesticide	µg/L			6.1		
Dichlorobenzene (1,2-)	Trace Organic	µg/L			0.70		
Dichlorobenzene (1,3-)	Trace Organic	µg/L			150		
Dichlorobenzene (1,4-)	Trace Organic	µg/L			26		
Dichloroethane (1,2-)	Trace Organic	µg/L			100		
Dichloromethane (Methylene chloride)	Trace Organic	µg/L			98.1		
Didecyl dimethyl ammonium chloride (DDAC)	Pesticide	µg/L			1.5		
Dieldrin	Pesticide	µg/L			~~0.004~~[1,2,3]	0.24	0.056
Dimethoate	Pesticide	µg/L			6.2		
Di-*n*-butyl phthalate	Trace Organic	µg/L			19		
Di(2-ethylhexyl) phthalate	Trace Organic	µg/L			16		
Dinoseb	Pesticide	µg/L			0.05		
Endosulfan, Alpha & Beta	Pesticide	µg/L			0.02	0.22[4,22]	0.056[4,22]
Endrin	Pesticide	µg/L			~~0.0023~~[1,2]	0.086	0.036
Ethylbenzene	Trace Organic	µg/L			90		
Ethylene glycol	Trace Organic	µg/L			192 000		
Fluoranthene	Trace Organic (PAH)	µg/L			0.04		
Fluorene	Trace Organic (PAH)	µg/L			3.0		
Gases (total dissolved)	Ions and General				Refer to CCME 1999 for narrative		<110% of saturation value
Glyphosate	Pesticide	µg/L			65		
Guthion	Pesticide	µg/L					0.01
Heptachlor (Heptachlor Epoxide)	Pesticide	µg/L			~~0.01~~[1,2]	0.52[4]	0.0038[4]

[20] Draft *Alberta Water Quality Guideline for the Protection of Freshwater Aquatic Life – Copper.* August 1996. The evaluation of chronic toxicity of copper in soft water was inconclusive; the chronic guideline can therefore only be applied at water hardness equal to or greater than 50 mg/L $CaCO_3$. Guideline applies to acid-extractable copper concentrations.

[21] CEQG guideline for copper is hardness dependent: 2 µg/L at [$CaCO_3$] = 0 to 120 mg/L, 3 µg/L at [$CaCO_3$] = 120 to 180 mg/L, and 4 µg/L at [$CaCO_3$] > 180 mg/L.

[22] USEPA guideline was derived from data for endosulfan and is more appropriately applied to the sum of alpha-endosulfan and beta-endosulfan.

TABLE 1.0 WATER QUALITY GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE

SUBSTANCE OR CONDITION	CATEGORY	UNIT	ALBERTA		CCME Shaded values are interim	USEPA	
			Acute	Chronic		Maximum Concentration	Continuous Concentration
Hexachlorobutadiene	Trace Organic	µg/L			1.3		
3-Iodo-2-propynyl butyl carbamate (IPBC or Iodocarb)	Pesticide	µg/L			1.9		
Iron	Metal	µg/L			300		1000
Lead	Metal	µg/L			1 to 7[23]	See Table 1.2	See Table 1.2
Lindane (Hexachlorocyclohexane)	Pesticide	µg/L			0.01	0.95	
Linuron	Pesticide	µg/L			7.0		
Malathion	Pesticide	µg/L					0.1
MCPA (4-chloro-2-methyl phenoxy acetic acid)	Pesticide	µg/L			2.6		
Mercury - total	Metal	µg/L	0.013[24]	0.005[24]	0.1	1.4[14, 25]	0.77[14, 25]
Mercury -methyl	Metal	µg/L	0.002[26]	0.001[26]			
Methoxychlor	Pesticide	µg/L					0.03
Metolachlor	Pesticide	µg/L			7.8		
Metribuzin	Pesticide	µg/L			1.0		
Mirex	Pesticide	µg/L					0.001
Molybdenum	Metal	µg/L			73		
Monochlorobenzene	Trace Organic	µg/L			1.3		
Naphthalene	Trace Organic (PAH)	µg/L			1.1		
Nickel	Metal	µg/L			25 to 150[27]	See Table 1.2	See Table 1.2
Nitrate[15]	Nutrient	mg/L			See Narrative[28]		
Nitrite	Nutrient	mg/L			0.06		
Nitrogen (total inorganic and organic)[15]	Nutrient	mg/L		1.0[17]			
Oxygen, Dissolved	Ions and General	mg/L	5.0 (1-day minimum)	6.5 (7-day mean)[29]	5.5 to 9.5[30]	3.0 to 9.5[31]	

[23] CEQG lead guideline is hardness dependent: 1 µg/L at [$CaCO_3$] = 0 to 60 mg/L; 2 µg/L at [$CaCO_3$] = 60 to 120 mg/L; 4 µg/L at [$CaCO_3$] = 120 to 180 mg/L; 7 µg/L at [$CaCO_3$] > 180 mg/L.

[24] Alberta guidelines for Mercury are draft.

[25] USEPA guideline for mercury was derived from data for inorganic mercury (II), but is applied here to total mercury. If a substantial portion of the mercury in the water column is methylmercury, this criterion will probably be under protective. In addition, even though inorganic mercury is converted to methylmercury, and methylmercury bioaccumulates to a great extent, this criterion does not account for uptake via the foodchain because sufficient data were not available when the criterion was derived.

[26] Alberta guidelines for Methylmercury are draft.

[27] CEQG guideline for nickel is hardness dependent: 25 µg/L at [$CaCO_3$] = 0 to 60 mg/L; 65 µg/L at [$CaCO_3$] = 60 to 120 mg/L; 110 µg/L at [$CaCO_3$] = 120 to 180 mg/L; 150 µg/L at [$CaCO_3$] > 180 mg/L.

[28] CEQG guideline for nitrate: concentrations that stimulate weed growth should be avoided.

[29] Alberta Dissolved Oxygen guideline: The chronic guideline should be increased to 8.3 from mid May to the end of June to protect emergence of mayfly species into adults. The chronic guideline should be increased to 9.5 mg/L for those areas and times where embryonic and larval stages (from spawning to 30 days after hatching) develop within gravel beds (some salmonids). The chronic guideline is increased by 3 mg/L to account for the depletion of dissolved oxygen within the gravel. Where natural conditions alone create dissolved oxygen concentrations less than 110% of the applicable criteria means or minima or both, the minimum acceptable concentration is 90% of the natural concentrations.

TABLE 1.0 WATER QUALITY GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE

SUBSTANCE OR CONDITION	CATEGORY	UNIT	ALBERTA		CCME	USEPA	
			Acute	Chronic	Shaded values are interim	Maximum Concentration	Continuous Concentration
Copper	Metal	µg/L	See Table 1.2	7[20]	2 to 4[21]	See Table 1.2	See Table 1.2
Cyanazine	Pesticide	µg/L			2.0		
Cyanide (as free CN)	Ions and General	µg/L			5	22	5.2
DDT (total) (Dichloro diphenyl trichloroethane)	Pesticide	µg/L			~~0.001~~[1, 2]	1.1[4]	0.001[4]
Deltamethrin	Pesticide	µg/L			0.0004		
Demeton	Pesticide	µg/L					0.1
Dicamba	Pesticide	µg/L			10		
Diclofop-methyl	Pesticide	µg/L			6.1		
Dichlorobenzene (1,2-)	Trace Organic	µg/L			0.70		
Dichlorobenzene (1,3-)	Trace Organic	µg/L			150		
Dichlorobenzene (1,4-)	Trace Organic	µg/L			26		
Dichloroethane (1,2-)	Trace Organic	µg/L			100		
Dichloromethane (Methylene chloride)	Trace Organic	µg/L			98.1		
Didecyl dimethyl ammonium chloride (DDAC)	Pesticide	µg/L			1.5		
Dieldrin	Pesticide	µg/L			~~0.004~~[1, 2, 3]	0.24	0.056
Dimethoate	Pesticide	µg/L			6.2		
Di-*n*-butyl phthalate	Trace Organic	µg/L			19		
Di(2-ethylhexyl) phthalate	Trace Organic	µg/L			16		
Dinoseb	Pesticide	µg/L			0.05		
Endosulfan, Alpha & Beta	Pesticide	µg/L			0.02	0.22[4, 22]	0.056[4, 22]
Endrin	Pesticide	µg/L			~~0.0023~~[1, 2]	0.086	0.036
Ethylbenzene	Trace Organic	µg/L			90		
Ethylene glycol	Trace Organic	µg/L			192 000		
Fluoranthene	Trace Organic (PAH)	µg/L			0.04		
Fluorene	Trace Organic (PAH)	µg/L			3.0		
Gases (total dissolved)	Ions and General				Refer to CCME 1999 for narrative		<110% of saturation value
Glyphosate	Pesticide	µg/L			65		
Guthion	Pesticide	µg/L					0.01
Heptachlor (Heptachlor Epoxide)	Pesticide	µg/L			~~0.01~~[1, 2]	0.52[4]	0.0038[4]

[20] Draft *Alberta Water Quality Guideline for the Protection of Freshwater Aquatic Life – Copper.* August 1996. The evaluation of chronic toxicity of copper in soft water was inconclusive; the chronic guideline can therefore only be applied at water hardness equal to or greater than 50 mg/L $CaCO_3$. Guideline applies to acid-extractable copper concentrations.

[21] CEQG guideline for copper is hardness dependent: 2 µg/L at [$CaCO_3$] = 0 to 120 mg/L, 3 µg/L at [$CaCO_3$] = 120 to 180 mg/L, and 4 µg/L at [$CaCO_3$] > 180 mg/L.

[22] USEPA guideline was derived from data for endosulfan and is more appropriately applied to the sum of alpha-endosulfan and beta-endosulfan.

TABLE 1.0 WATER QUALITY GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE

SUBSTANCE OR CONDITION	CATEGORY	UNIT	ALBERTA		CCME	USEPA	
			Acute	Chronic	Shaded values are interim	Maximum Concentration	Continuous Concentration
Hexachlorobutadiene	Trace Organic	µg/L			1.3		
3-Iodo-2-propynyl butyl carbamate (IPBC or Iodocarb)	Pesticide	µg/L			1.9		
Iron	Metal	µg/L			300		1000
Lead	Metal	µg/L			1 to 7[23]	See Table 1.2	See Table 1.2
Lindane (Hexachlorocyclohexane)	Pesticide	µg/L			0.01	0.95	
Linuron	Pesticide	µg/L			7.0		
Malathion	Pesticide	µg/L					0.1
MCPA (4-chloro-2-methyl phenoxy acetic acid)	Pesticide	µg/L			2.6		
Mercury - total	Metal	µg/L	0.013[24]	0.005[24]	0.1	1.4[14, 25]	0.77[14, 25]
Mercury -methyl	Metal	µg/L	0.002[26]	0.001[26]			
Methoxychlor	Pesticide	µg/L					0.03
Metolachlor	Pesticide	µg/L			7.8		
Metribuzin	Pesticide	µg/L			1.0		
Mirex	Pesticide	µg/L					0.001
Molybdenum	Metal	µg/L			73		
Monochlorobenzene	Trace Organic	µg/L			1.3		
Naphthalene	Trace Organic (PAH)	µg/L			1.1		
Nickel	Metal	µg/L			25 to 150[27]	See Table 1.2	See Table 1.2
Nitrate[15]	Nutrient	mg/L			See Narrative[28]		
Nitrite	Nutrient	mg/L			0.06		
Nitrogen (total inorganic and organic)[15]	Nutrient	mg/L		1.0[17]			
Oxygen, Dissolved	Ions and General	mg/L	5.0 (1-day minimum)	6.5 (7-day mean)[29]	5.5 to 9.5[30]	3.0 to 9.5[31]	

[23] CEQG lead guideline is hardness dependent: 1 µg/L at [$CaCO_3$] = 0 to 60 mg/L; 2 µg/L at [$CaCO_3$] = 60 to 120 mg/L; 4 µg/L at [$CaCO_3$] = 120 to 180 mg/L; 7 µg/L at [$CaCO_3$] > 180 mg/L.

[24] Alberta guidelines for Mercury are draft.

[25] USEPA guideline for mercury was derived from data for inorganic mercury (II), but is applied here to total mercury. If a substantial portion of the mercury in the water column is methylmercury, this criterion will probably be under protective. In addition, even though inorganic mercury is converted to methylmercury, and methylmercury bioaccumulates to a great extent, this criterion does not account for uptake via the foodchain because sufficient data were not available when the criterion was derived.

[26] Alberta guidelines for Methylmercury are draft.

[27] CEQG guideline for nickel is hardness dependent: 25 µg/L at [$CaCO_3$] = 0 to 60 mg/L; 65 µg/L at [$CaCO_3$] = 60 to 120 mg/L; 110 µg/L at [$CaCO_3$] = 120 to 180 mg/L; 150 µg/L at [$CaCO_3$] > 180 mg/L.

[28] CEQG guideline for nitrate: concentrations that stimulate weed growth should be avoided.

[29] Alberta Dissolved Oxygen guideline: The chronic guideline should be increased to 8.3 from mid May to the end of June to protect emergence of mayfly species into adults. The chronic guideline should be increased to 9.5 mg/L for those areas and times where embryonic and larval stages (from spawning to 30 days after hatching) develop within gravel beds (some salmonids). The chronic guideline is increased by 3 mg/L to account for the depletion of dissolved oxygen within the gravel. Where natural conditions alone create dissolved oxygen concentrations less than 110% of the applicable criteria means or minima or both, the minimum acceptable concentration is 90% of the natural concentrations.

TABLE 1.0 WATER QUALITY GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE

SUBSTANCE OR CONDITION	CATEGORY	UNIT	ALBERTA		CCME Shaded values are interim	USEPA	
			Acute	Chronic		Maximum Concentration	Continuous Concentration
Parathion	Pesticide	µg/L				0.065	0.013
PCBs (total) (Polychlorinated biphenyls)	Trace Organic	µg/L			0.001[1,2]		0.014[32]
Pentachlorobenzene	Trace Organic	µg/L			6.0		
pH	Ions and General		See Narrative[33]		6.5 to 9.0		6.5 to 9.0
Phenanthrene	Trace Organic (PAH)	µg/L			0.4		
Phenolics	Trace Organic	µg/L		5[17]			
Phenols (mono and dihydric)	Trace Organic	µg/L			4.0		
Phosphorus as P (total inorganic and organic)[15]	Nutrient	mg/L		0.05[17]			
Picloram	Pesticide	µg/L			29		
Propylene glycol	Trace Organic	µg/L			500 000		
Pyrene	Trace Organic (PAH)	µg/L			0.025		
Quinoline	Trace Organic (PAH)	µg/L			3.4		
Resin acids	Trace Organic	µg/L		100[17]			
Selenium	Metal	µg/L			1.0	See narrative[34]	5.0[35]
Silver	Metal	µg/L			0.1	See Table 1.2[4]	
Simazine	Pesticide	µg/L			10		
Styrene	Trace Organic	µg/L			72		
Sulphide (H_2S)	Ions and General	µg/L					2.0

[30] CEQG Dissolved Oxygen guideline:
for warm water biota: early life stages = 6 mg/L
other life stages = 5.5 mg/L
for cold water biota: early life stages = 9.5 mg/L
other life stages = 6.5 mg/L.

[31] USEPA Dissolved Oxygen guidelines:
for warm water biota: early life stages = 6 mg/L (7 day mean), 5.0 mg/L (1 day minimum)
other life stages = 5.5 mg/L (30 day mean), 4.0 mg/L (7 day mean minimum), 3.0 mg/L (1 day minimum)
for cold water biota: early life stages = 9.5 mg/L (7 day mean intergravel DO concentration), 6.5 mg/L (7 day mean water column DO concentration), 8.0 (1 day minimum mean intergravel DO concentration), 5.0 mg/L (1 day mean water column DO concentration)
other life stages = 6.5 mg/L (30 day mean), 5.0 mg/L (7 day mean), 4.0 (1 day minimum).

[32] USEPA guideline for PCBs – PCBs are a class of chemicals which include aroclors 1242, 1254, 1221, 1232, 1248, 1260, and 1016. The aquatic life criteria apply to this set of PCBs.
[33] Alberta pH guideline: To be in the range of 6.5 to 8.5 but not altered by more than 0.5 pH units from background values.
[34] USEPA guideline for selenium: The maximum concentration = 1/[(f1/CMC1)+(f2/CMC2)], where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively, and CMC1 and CMC2 are 185.9 µg/L and 12.83 µg/L, respectively.
[35] The USEPA recommended water quality criterion for selenium is expressed in terms of total recoverable metal in the water column. It is scientifically acceptable to use the conversion factor of 0.922 to convert this to a value that is expressed in terms of dissolved metal.

TABLE 1.0 WATER QUALITY GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE

SUBSTANCE OR CONDITION	CATEGORY	UNIT	ALBERTA		CCME Shaded values are interim	USEPA	
			Acute	Chronic		Maximum Concentration	Continuous Concentration
Suspended Solids	Physical	mg/L	Not to be increased by more than 10 mg/L over background value[17]		See narrative statement[36]	See narrative statement[37]	
Tebuthiuron	Pesticide	µg/L			1.6		
Temperature	Physical	°C	Not to be increased by more than 3°C above ambient water temperature[17]		See narrative statement[38]		
Tetrachlorobenzene (1,2,3,4-)	Trace Organic	µg/L			1.8		
Tetrachloroethylene (1,1,2,2-) (PCE)	Trace Organic	µg/L			111		
Thallium	Metal	µg/L			0.8		
Toluene	Trace Organic	µg/L			2.0		
Toxaphene	Pesticide	µg/L			0.008[1,2]	0.73	0.0002
Triallate	Pesticide	µg/L			0.24		
Tributyltin	Trace Organic	µg/L			0.008	0.46	0.063
Trichlorobenzene (1,2,4)	Trace Organic	µg/L			24		
Trichlorobenzene (1,2,3)	Trace Organic	µg/L			8.0		
Trichloroethene (1,1,2-) (Trichloroethylene)	Trace Organic	µg/L			21		
Trifluralin	Pesticide	µg/L			0.20		
Triphenyltin	Trace Organic	µg/L			0.022		
Turbidity	Physical	NTU			See narrative[39]		
Zinc	Metal	µg/L			30	See Table 1.2	See Table 1.2

[36] CEQG Suspended solids guideline:
For clear flow - Maximum increase of 25 mg/L from background levels for any short-term exposure (e.g., 24-h period). Maximum increase of 5 mg/L from background levels for any long-term exposure (e.g., inputs lasting between 24 h and 30 d).
For high flow - Maximum increase of 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L. Should not increase more than 10% of background levels when background is >250 mg/L.

[37] USEPA Suspended solids guideline: Settleable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10% from the seasonally established norm for aquatic life (for solids – suspended, settleable, and turbidity).

[38] CEQG Temperature guideline: Thermal additions should not alter thermal stratification or turnover dates, exceed maximum weekly average temperatures, nor exceed maximum short-term temperatures.

[39] CEQG Turbidity guideline:
For clear flow - Maximum increase of 8 NTU from background levels for any short-term exposure (e.g., 24-h period). Maximum increase of 2 NTU from background levels for any long-term exposure (e.g. ,inputs lasting between 24-h and 30-d).
For high flow or turbid waters - Maximum increase of 8 NTU from background levels at any one time when background levels are between 8 and 80 NTU. Should not increase more than 10% of background levels when background is >80 NTU.

TABLE 1.0 WATER QUALITY GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE

SUBSTANCE OR CONDITION	CATEGORY	UNIT	ALBERTA		CCME	USEPA	
			Acute	Chronic	Shaded values are interim	Maximum Concentration	Continuous Concentration
Parathion	Pesticide	µg/L				0.065	0.013
PCBs (total) (Polychlorinated biphenyls)	Trace Organic	µg/L			0.001[1, 2]		0.014[32]
Pentachlorobenzene	Trace Organic	µg/L			6.0		
pH	Ions and General		See Narrative[33]		6.5 to 9.0		6.5 to 9.0
Phenanthrene	Trace Organic (PAH)	µg/L			0.4		
Phenolics	Trace Organic	µg/L		5[17]			
Phenols (mono and dihydric)	Trace Organic	µg/L			4.0		
Phosphorus as P (total inorganic and organic)[15]	Nutrient	mg/L		0.05[17]			
Picloram	Pesticide	µg/L			29		
Propylene glycol	Trace Organic	µg/L			500 000		
Pyrene	Trace Organic (PAH)	µg/L			0.025		
Quinoline	Trace Organic (PAH)	µg/L			3.4		
Resin acids	Trace Organic	µg/L		100[17]			
Selenium	Metal	µg/L			1.0	See narrative[34]	5.0[35]
Silver	Metal	µg/L			0.1	See Table 1.2[4]	
Simazine	Pesticide	µg/L			10		
Styrene	Trace Organic	µg/L			72		
Sulphide (H_2S)	Ions and General	µg/L					2.0

[30] CEQG Dissolved Oxygen guideline:
for warm water biota: early life stages = 6 mg/L
other life stages = 5.5 mg/L
for cold water biota: early life stages = 9.5 mg/L
other life stages = 6.5 mg/L.

[31] USEPA Dissolved Oxygen guidelines:
for warm water biota: early life stages = 6 mg/L (7 day mean), 5.0 mg/L (1 day minimum)
other life stages = 5.5 mg/L (30 day mean), 4.0 mg/L (7 day mean minimum), 3.0 mg/L (1 day minimum)
for cold water biota: early life stages = 9.5 mg/L (7 day mean intergravel DO concentration), 6.5 mg/L (7 day mean water column DO concentration), 8.0 (1 day minimum mean intergravel DO concentration), 5.0 mg/L (1 day mean water column DO concentration)
other life stages = 6.5 mg/L (30 day mean), 5.0 mg/L (7 day mean), 4.0 (1 day minimum).

[32] USEPA guideline for PCBs – PCBs are a class of chemicals which include aroclors 1242, 1254, 1221, 1232, 1248, 1260, and 1016. The aquatic life criteria apply to this set of PCBs.
[33] Alberta pH guideline: To be in the range of 6.5 to 8.5 but not altered by more than 0.5 pH units from background values.
[34] USEPA guideline for selenium: The maximum concentration = 1/[(f1/CMC1)+(f2/CMC2)], where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively, and CMC1 and CMC2 are 185.9 µg/L and 12.83 µg/L, respectively.
[35] The USEPA recommended water quality criterion for selenium is expressed in terms of total recoverable metal in the water column. It is scientifically acceptable to use the conversion factor of 0.922 to convert this to a value that is expressed in terms of dissolved metal.

TABLE 1.0 WATER QUALITY GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE

SUBSTANCE OR CONDITION	CATEGORY	UNIT	ALBERTA		CCME	USEPA	
			Acute	Chronic	Shaded values are interim	Maximum Concentration	Continuous Concentration
Suspended Solids	Physical	mg/L	Not to be increased by more than 10 mg/L over background value[17]		See narrative statement[36]	See narrative statement[37]	
Tebuthiuron	Pesticide	µg/L			1.6		
Temperature	Physical	°C	Not to be increased by more than 3°C above ambient water temperature[17]		See narrative statement[38]		
Tetrachlorobenzene (1,2,3,4-)	Trace Organic	µg/L			1.8		
Tetrachloroethylene (1,1,2,2-) (PCE)	Trace Organic	µg/L			111		
Thallium	Metal	µg/L			0.8		
Toluene	Trace Organic	µg/L			2.0		
Toxaphene	Pesticide	µg/L			~~0.008~~[1,2]	0.73	0.0002
Triallate	Pesticide	µg/L			0.24		
Tributyltin	Trace Organic	µg/L			0.008	0.46	0.063
Trichlorobenzene (1,2,4)	Trace Organic	µg/L			24		
Trichlorobenzene (1,2,3)	Trace Organic	µg/L			8.0		
Trichloroethene (1,1,2-) (Trichloroethylene)	Trace Organic	µg/L			21		
Trifluralin	Pesticide	µg/L			0.20		
Triphenyltin	Trace Organic	µg/L			0.022		
Turbidity	Physical	NTU			See narrative[39]		
Zinc	Metal	µg/L			30	See Table 1.2	See Table 1.2

[36] CEQG Suspended solids guideline:
For clear flow - Maximum increase of 25 mg/L from background levels for any short-term exposure (e.g., 24-h period). Maximum increase of 5 mg/L from background levels for any long-term exposure (e.g., inputs lasting between 24 h and 30 d).
For high flow - Maximum increase of 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L. Should not increase more than 10% of background levels when background is >250 mg/L.

[37] USEPA Suspended solids guideline: Settleable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10% from the seasonally established norm for aquatic life (for solids – suspended, settleable, and turbidity).

[38] CEQG Temperature guideline: Thermal additions should not alter thermal stratification or turnover dates, exceed maximum weekly average temperatures, nor exceed maximum short-term temperatures.

[39] CEQG Turbidity guideline:
For clear flow - Maximum increase of 8 NTU from background levels for any short-term exposure (e.g., 24-h period). Maximum increase of 2 NTU from background levels for any long-term exposure (e.g. ,inputs lasting between 24-h and 30-d).
For high flow or turbid waters - Maximum increase of 8 NTU from background levels at any one time when background levels are between 8 and 80 NTU. Should not increase more than 10% of background levels when background is >80 NTU.

TABLE 1.1 AMMONIA GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE (USEPA 1999).
(Units are mg Nitrogen /L)

pH	CMC - salmonids present	CMC - no salmonids present	CCC - 30 day average
6.5	32.61	48.83	3.48
6.6	31.28	46.84	3.43
6.7	29.76	44.57	3.36
6.8	28.05	42.00	3.29
6.9	26.15	39.16	3.19
7.0	24.10	36.09	3.08
7.1	21.94	32.86	2.96
7.2	19.73	29.54	2.81
7.3	17.51	26.21	2.65
7.4	15.34	22.97	2.47
7.5	13.28	19.89	2.28
7.6	11.37	17.03	2.08
7.7	9.64	14.44	1.87
7.8	8.11	12.14	1.66
7.9	6.77	10.13	1.46
8.0	5.62	8.41	1.27
8.1	4.64	6.95	1.09
8.2	3.83	5.73	0.94
8.3	3.15	4.71	0.80
8.4	2.59	3.88	0.67
8.5	2.14	3.20	0.57
8.6	1.77	2.65	0.48
8.7	1.47	2.20	0.41
8.8	1.23	1.84	0.35
8.9	1.04	1.56	0.29
9.0	0.88	1.32	0.25

USEPA calculation for freshwater ammonia criteria

1. The one-hour average concentration of total ammonia nitrogen (in mg Nitrogen per L) does not exceed, more than once every three years on the average, the CMC calculated using the following equation:

   $CMC = 0.275/(1+10^{7.204-pH})+39.0/(1+10^{pH-7.204})$

   In situations where salmonids do not occur, the CMC may be calculated using the following equation:

   $CMC=0.411/(1+10^{7.204-pH})+58.4/(1+10^{pH-7.204})$

2. The thirty day average concentration of total ammonia nitrogen (in mg N/L) does not exceed, more than once every three years on average, the CCC calculated using the following equation:

   $CCC=0.0858/(1+10^{7.688-pH})+3.70/(1+10^{pH-7.688})$

   The highest four-day average within the thirty days should not be greater than twice the CCC.

TABLE 1.2 METAL GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE
(Values in µg/L unless otherwise noted)

Hardness (mg/L as $CaCO_3$)	CCME Cadmium[1]	USEPA Cadmium[2]		USEPA Chromium III[2]	
		Maximum	Continuous	Maximum	Continuous
10	0.005	0.3	0.4	86	11
50	0.018	2.0	1.3	320	42
100	0.033	4.3	2.2	570	74
125	0.040	5.4	2.6	680	89
150	0.047	6.6	3.0	790	100
175	0.054	7.8	3.4	900	120
200	0.060	9.0	3.7	1000	130
225	0.067	10	4.1	1100	140
250	0.073	12	4.4	1200	160
275	0.079	13	4.7	1300	170
300	0.085	14	5.0	1400	180
325	0.091	15	5.3	1500	190
350	0.097	17	5.6	1600	210

Hardness (mg/L as $CaCO_3$)	Draft Alberta Copper[3]	USEPA Copper[2,4]		USPEA Lead[2]	
	Acute	Maximum	Continuous	Maximum	Continuous
10	1.7	1.5	1.3	5	0.2
50	8.1	7.0	5.0	30	1.2
100	16	13	9.0	65	2.5
125	20	17	11	82	3.2
150	24	20	13	100	3.9
175	28	23	14	120	4.6
200	32	26	16	140	5.3
225	35	29	18	150	6.0
250	39	32	20	170	6.7
275	43	35	21	190	7.4
300	47	38	23	210	8.1
325	51	41	25	230	8.8
350	55	44	26	240	9.5

Hardness (mg/L as $CaCO_3$)	USEPA Nickel[2]		USEPA Silver[2,5]		USEPA Zinc[2]	
	Maximum	Continuous	Maximum	Continuous	Maximum	Continuous
10	67	7	0.1	NA	17	17
50	260	29	1.0	NA	65	66
100	470	52	3.4	NA	120	120
125	570	63	5.1	NA	140	140
150	660	73	6.9	NA	170	170
175	750	83	9.0	NA	190	190
200	840	93	11	NA	210	210
225	930	100	14	NA	230	230
250	1000	110	17	NA	250	260
275	1100	120	20	NA	280	280
300	1200	130	23	NA	300	300
325	1300	140	26	NA	320	320
350	1400	150	30	NA	340	340

[1] CEQG interim cadmium guideline = $10^{\{0.86[\log(\text{hardness})]-3.2\}}$

[2] USEPA guideline values for metals are expressed in terms of the dissolved metal in the water column. Conversion factors to convert total recoverable metal to dissolved are given in Table 1.3.

[3] Draft *Alberta Water Quality Guideline for the Protection of Freshwater Aquatic Life – Copper.* August 1996. Guideline applies to acid-extractable copper concentrations.
Alberta acute guideline for copper = $e^{[0.979123*\ln(\text{hardness})-8.64497]}$

[4] USEPA guideline indicates that when the concentration of dissolved organic carbon is elevated, copper is substantially less toxic and use of Water-Effects Ratios might be appropriate.

[5] USEPA Guideline based on aquatic life criterion issued in 1980. The minimum data requirements and derivation procedures were different in the 1980 USEPA guidelines than in the 1985 USEPA guidelines. For example, a CMC derived using the 1980 guideline was derived to be used as an instantaneous maximum. If assessment is to be done using an averaging period, the values given should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 guidelines.

TABLE 1.3 USEPA PARAMETERS FOR CALCULATING HARDNESS – DEPENDENT METAL CONCENTRATIONS FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE

Metal	m_A	b_A	m_C	b_C	Freshwater Conversion Factor (CF) for converting total metal to dissolved metal concentration	
					Acute	Chronic
Cadmium	1.128	-3.6867	0.7852	-2.715	1.136672-[ln (hardness)(0.041838)]	1.101672-[ln (hardness)(0.041838)]
Chromium III	0.8190	3.7256	0.8190	0.6848	0.316	0.860
Copper	0.9422	-1.700	0.8545	-1.702	0.960	0.960
Lead	1.273	-1.460	1.273	-4.705	1.46203-[ln (hardness)(0.145712)]	1.46203-[ln (hardness)(0.145712)]
Nickel	0.8460	2.255	0.8460	0.0584	0.998	0.997
Silver	1.72	-6.52	–	–	0.85	–
Zinc	0.8473	0.884	0.8473	0.884	0.978	0.986

The freshwater guidelines for metals are expressed as a function of hardness (mg/L) in the water column. The value given in Table 1.0 corresponds to a hardness of 100 mg/L. Values for other hardness levels may be calculated from the following equations, using the parameters specified in Table 1.3 for each metal. Metal concentrations will be in µg/L.

$$\text{CMC (dissolved)} = \exp\{m_A[\ln(\text{hardness})]+b_A\}(\text{CF})$$
$$\text{CCC (dissolved)} = \exp\{m_C[\ln(\text{hardness})]+b_C\}(\text{CF})$$

$$\text{CMC (total recoverable)} = \exp\{m_A[\ln(\text{hardness})]+b_A\}$$
$$\text{CCC (total recoverable)} = \exp\{m_C[\ln(\text{hardness})]+b_C\}$$

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TABLE 2.0 WATER QUALITY GUIDELINES FOR AGRICULTURAL USES (CCME 1999)

SUBSTANCE OR CONDITION	CATEGORY	UNIT	IRRIGATION WATER	LIVESTOCK WATER
Aldicarb	Pesticide	µg/L	54.9	11
Aluminum	Metal	µg/L	5000	5000
Arsenic	Metal	µg/L	100	25
Atrazine	Pesticide	µg/L	10	5[1]
Beryllium	Metal	µg/L	100	100
Blue-green algae (Cyanobacteria)	Biological			Avoid heavy growth
Boron	Metal	µg/L	500 to 6000[2]	5000
Bromacil	Pesticide	µg/L	0.2	1100
Bromoform (Tribromomethane)	Trace Organic	µg/L		100[1]
Bromoxynil	Pesticide	µg/L	0.33	11
Cadmium	Metal	µg/L	5.1[3]	80
Calcium	Ions and General	mg/L		1000
Captan	Pesticide	µg/L		13
Carbaryl	Pesticide	µg/L		1100
Carbofuran	Pesticide	µg/L		45
Carbon tetrachloride	Trace Organic	µg/L		5
Chlordane	Pesticide	µg/L		7[4,5]

[1] During the development of this guideline, insufficient data were available to derive a livestock watering guideline value. Therefore, the Canadian drinking water quality guideline was adopted. Since then, this value has been revised by Health Canada (1996). This revised drinking water quality guideline is now adopted for livestock water.

[2] Boron guideline:

500 µg/L for:	blackberries
500 to 1000 µg/L for :	peaches, cherries, plums, grapes, cowpeas, onions, garlic, sweet potatoes, wheat, barley, sunflowers, mung beans, sesame, lupins, strawberries, Jerusalem artichokes, kidney beans, and lima beans;
1000 to 2000 µg/L for:	red peppers, peas, carrots, radishes, potatoes and cucumbers;
2000 to 4000 µg/L for:	lettuce, cabbages, celery, turnips, Kentucky bluegrass, oats, corn, artichokes, tobacco, mustard, clover, squash and muskmelons;
4000 to 6000 µg/L for:	sorghum, tomatoes, alfalfa, purple vetch, parsley, red beets and sugar beets;
6000 µg/L for:	asparagus.

[3] Cadmium guideline is crop specific. See fact sheet (CCME 1999).

[4] CCME no longer recommends this guideline and has withdrawn the value. CCME does not recommend a water quality guideline. Environmental exposure is predominantly via sediment, soil, and/or tissue; therefore, the reader is referred to the respective CEQG guidelines for these media.

[5] This substance meets the criteria for a Track 1 substance under the national CCME Policy for the Management of Toxic Substances (PMTS) (i.e., persistent, bioaccumulative, primarily the result of human activity, and Canadian Environmental Protection Act-toxic or equivalent) and should be subject to virtual elimination strategies. Guidelines can serve as action levels or interim management objectives towards virtual elimination.

TABLE 2.0 WATER QUALITY GUIDELINES FOR AGRICULTURAL USES (CCME 1999)

SUBSTANCE OR CONDITION	CATEGORY	UNIT	IRRIGATION WATER	LIVESTOCK WATER
Chloride	Ions and General	mg/L	100 - 700[6]	
Chloroform (Trichloromethane)	Trace Organic	µg/L		100[1]
Chlorothalonil	Pesticide	µg/L	5.8	170
Chlorpyrifos	Pesticide	µg/L		24
Chromium III	Metal	µg/L	4.9	50
Chromium VI	Metal	µg/L	8.0	50
Cobalt	Metal	µg/L	50	1000
Coliform bacteria (fecal)	Biological	#/100 mL	100/100 mL	
Coliform bacteria (total)[7]	Biological	#/100 mL	1000/100 mL	
Copper	Metal	µg/L	200-1000[8]	500 - 5000[9]
Cyanazine	Pesticide	µg/L	0.5	10
DDT (Dichloro diphenyl trichloroethane)	Pesticide	µg/L		30[4,5]
Deltamethrin	Pesticide	µg/L		2.5
Dicamba	Pesticide	µg/L	0.006	122
Dibromochloromethane	Trace Organic	µg/L		100[1]
Dichlorobromomethane	Trace Organic	µg/L		100[1]
Dichloroethane (1,2)	Trace Organic	µg/L		5
Diclofop-methyl	Pesticide	µg/L	0.18	9
Dimethoate	Pesticide	µg/L		3
Dinoseb	Pesticide	µg/L	16	150
Endrin	Pesticide	µg/L		0.2[4,5]
Ethylbenzene	Trace Organic	µg/L		2.4
Fluoride	Ions and General	mg/L	1	1 - 2[10]

[6] Chloride guideline

Foliar damage
- 100 – 178 mg/L: for almonds, apricots and plums;
- 178 - 355 mg/L: for grapes, peppers, potatoes and tomatoes;
- 355 - 710 mg/L: for alfalfa, barley, corn and cucumbers;
- >710 mg/L: for cauliflower, cotton, safflower, sesame, sorghum, sugar beets and sunflowers;

Rootstocks
- 180 - 600 mg/L: for stone fruit (peaches, plums, etc.)
- 710 - 900 mg/L: for grapes;

Cultivars
- 110 - 180 mg/L: for strawberries;
- 230 - 460 mg/L: for grapes;
- 250 mg/L: for boysenberries, blackberries and raspberries.

[7] The Alberta guideline for vegetable crop irrigation states that the geometric mean of not less than five samples taken over not more than a 30-day period should not exceed 1000 organisms per 100 mL for total coliforms, nor 200 organisms per 100 mL for fecal coliforms, nor exceed these numbers in more than 20 percent of the samples examined during any month, nor exceed 2400 organisms per 100 mL total coliforms on any day.

[8] Copper guideline: 200 µg/L for cereals and 1000 µg/L for tolerant crops.

[9] Copper guideline: 500 µg/L for sheep, 1000 µg/L for cattle, 5000 µg/L for swine and poultry.

[10] Fluoride guideline: 1 mg/L if feed contains fluoride.

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Atrazine	Pesticide	µg/L	10	5[1]
Beryllium	Metal	µg/L	100	100
Blue-green algae (Cyanobacteria)	Biological			Avoid heavy growth
Boron	Metal	µg/L	500 to 6000[2]	5000
Bromacil	Pesticide	µg/L	0.2	1100
Bromoform (Tribromomethane)	Trace Organic	µg/L		100[1]
Bromoxynil	Pesticide	µg/L	0.33	11
Cadmium	Metal	µg/L	5.1[3]	80
Calcium	Ions and General	mg/L		1000
Captan	Pesticide	µg/L		13
Carbaryl	Pesticide	µg/L		1100
Carbofuran	Pesticide	µg/L		45
Carbon tetrachloride	Trace Organic	µg/L		5
Chlordane	Pesticide	µg/L		-[4,5]

[1] During the development of this guideline, insufficient data were available to derive a livestock watering guideline value. Therefore, the Canadian drinking water quality guideline was adopted. Since then, this value has been revised by Health Canada (1996). This revised drinking water quality guideline is now adopted for livestock water.

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2000 to 4000 µg/L for:	lettuce, cabbages, celery, turnips, Kentucky bluegrass, oats, corn, artichokes, tobacco, mustard, clover, squash and muskmelons;
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Chlorpyrifos	Pesticide	µg/L		24
Chromium III	Metal	µg/L	4.9	50
Chromium VI	Metal	µg/L	8.0	50
Cobalt	Metal	µg/L	50	1000
Coliform bacteria (fecal)	Biological	#/100 mL	100/100 mL	
Coliform bacteria (total)[7]	Biological	#/100 mL	1000/100 mL	
Copper	Metal	µg/L	200-1000[8]	500 - 5000[9]
Cyanazine	Pesticide	µg/L	0.5	10
DDT (Dichloro diphenyl trichloroethane)	Pesticide	µg/L		30[4,5]
Deltamethrin	Pesticide	µg/L		2.5
Dicamba	Pesticide	µg/L	0.006	122
Dibromochloromethane	Trace Organic	µg/L		100[1]
Dichlorobromomethane	Trace Organic	µg/L		100[1]
Dichloroethane (1,2)	Trace Organic	µg/L		5
Diclofop-methyl	Pesticide	µg/L	0.18	9
Dimethoate	Pesticide	µg/L		3
Dinoseb	Pesticide	µg/L	16	150
Endrin	Pesticide	µg/L		0.2[4,5]
Ethylbenzene	Trace Organic	µg/L		2.4
Fluoride	Ions and General	mg/L	1	1 - 2[10]

[6] Chloride guideline

Foliar damage
- 100 – 178 mg/L: for almonds, apricots and plums;
- 178 - 355 mg/L: for grapes, peppers, potatoes and tomatoes;
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- 180 - 600 mg/L: for stone fruit (peaches, plums, etc.)
- 710 - 900 mg/L: for grapes;

Cultivars
- 110 - 180 mg/L: for strawberries;
- 230 - 460 mg/L: for grapes;
- 250 mg/L: for boysenberries, blackberries and raspberries.

[7] The Alberta guideline for vegetable crop irrigation states that the geometric mean of not less than five samples taken over not more than a 30-day period should not exceed 1000 organisms per 100 mL for total coliforms, nor 200 organisms per 100 mL for fecal coliforms, nor exceed these numbers in more than 20 percent of the samples examined during any month, nor exceed 2400 organisms per 100 mL total coliforms on any day.

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[10] Fluoride guideline: 1 mg/L if feed contains fluoride.

TABLE 2.0 WATER QUALITY GUIDELINES FOR AGRICULTURAL USES (CCME 1999)

SUBSTANCE OR CONDITION	CATEGORY	UNIT	IRRIGATION WATER	LIVESTOCK WATER
Glyphosate	Pesticide	µg/L		280
Heptachlor (heptachlor epoxide)	Pesticide	µg/L		[4,5]
Hexachlorobenzene	Trace Organic	µg/L		0.52
Iron	Metal	µg/L	5000	
Lead	Metal	µg/L	200	100
Lindane (Hexachlorocyclohexane)	Pesticide	µg/L		4[11]
Linuron	Pesticide	µg/L	0.071	
Lithium	Metal	µg/L	2500	
Manganese	Metal	µg/L	200	
Mercury	Metal	µg/L		3
Methyl chloro phenoxy acetic acid (2,4-) (MCPA)	Pesticide	µg/L	0.025	25
Methylene chloride (Dichloromethane)	Trace Organic	µg/L		50
Metolachlor	Pesticide	µg/L	28	50
Metribuzin	Pesticide	µg/L	0.5	80
Molybdenum	Metal	µg/L	10 - 50[12]	500
Nickel	Metal	µg/L	200	1000
Nitrate + Nitrite	Nutrient	mg/L		100
Nitrite	Nutrient	mg/L		10
Phenol	Trace Organic	µg/L		2
Phenoxy herbicides	Pesticide	µg/L		100
Picloram	Pesticide	µg/L		190
Selenium	Metal	µg/L	20 - 50[13]	50
Simazine	Pesticide	µg/L	0.5	10
Sulphate	Ions and General	mg/L		1000
Tebuthiuron	Pesticide	µg/L	0.27 (cereals)	130
Toluene	Trace Organic	µg/L		24
Total Dissolved Solids (TDS)	Ions and General	mg/L	500 – 3500[14]	3000

[11] Guidelines can serve as action levels or interim management objectives towards virtual elimination.
[12] Molybdenum guideline: 50 µg/L for short-term use on acidic soils.
[13] Selenium guideline: 20 µg/L for continuous use and 50 µg/L for intermittent use.
[14] Total dissolved solids guideline:

500 mg/L for:	strawberries, raspberries, beans and carrots;
500-800 mg/L for:	boysenberries, currants, blackberries, gooseberries, plums, grapes, apricots, peaches, pears, cherries, apples, onions, parsnips, radishes, peas, pumpkins, lettuce, peppers, muskmelons, sweet potatoes, sweet corn, potatoes, celery, cabbage, kohlrabi, cauliflower, cowpeas, broadbeans, flax, sunflowers and corn;
800-1500 mg/L for:	spinach, cantaloupes, cucumbers, tomatoes, squash, brussel sprouts, broccoli, turnips, smooth brome, alfalfa, big trefoil, beardless wildrye, vetch, timothy and crested wheat grass;
1500-2500 mg/L for:	beets, zucchini, rape, sorghum, oat hay, wheat hay, mountain brome, tall fescue, sweet clover, reed canary grass, birdsfoot trefoil and perennial ryegrass;
3500 mg/L for:	asparagus, soybeans, safflower, oats, rye, wheat, sugar beets, barley, barley hay and tall wheat grass.

TABLE 2.0 WATER QUALITY GUIDELINES FOR AGRICULTURAL USES (CCME 1999)

SUBSTANCE OR CONDITION	CATEGORY	UNIT	IRRIGATION WATER	LIVESTOCK WATER
Toxaphene	Pesticide	µg/L		5[4,5]
Trialiate	Pesticide	µg/L		230
Tributyltin	Trace Organic	µg/L		250
Trichloroethylene (1,1,2-trichloroethene)	Trace Organic	µg/L		50
Tricyclohexyltin	Trace Organic	µg/L		250
Trifluralin	Pesticide	µg/L		45
Triphenyltin	Trace Organic	µg/L		820
Uranium	Metal	µg/L	10	200
Vanadium	Metal	µg/L	100	100
Zinc	Metal	µg/L	1000 to 5000[15]	50 000

[15] CEQG irrigation guideline for zinc: 1000 µg/L when soil pH < 6.5; 5000 µg/L when soil pH > 6.5.

TABLE 2.0 WATER QUALITY GUIDELINES FOR AGRICULTURAL USES (CCME 1999)

SUBSTANCE OR CONDITION	CATEGORY	UNIT	IRRIGATION WATER	LIVESTOCK WATER
Glyphosate	Pesticide	µg/L		280
Heptachlor (heptachlor epoxide)	Pesticide	µg/L		3[4,5]
Hexachlorobenzene	Trace Organic	µg/L		0.52
Iron	Metal	µg/L	5000	
Lead	Metal	µg/L	200	100
Lindane (Hexachlorocyclohexane)	Pesticide	µg/L		4[11]
Linuron	Pesticide	µg/L	0.071	
Lithium	Metal	µg/L	2500	
Manganese	Metal	µg/L	200	
Mercury	Metal	µg/L		3
Methyl chloro phenoxy acetic acid (2,4-) (MCPA)	Pesticide	µg/L	0.025	25
Methylene chloride (Dichloromethane)	Trace Organic	µg/L		50
Metolachlor	Pesticide	µg/L	28	50
Metribuzin	Pesticide	µg/L	0.5	80
Molybdenum	Metal	µg/L	10 - 50[12]	500
Nickel	Metal	µg/L	200	1000
Nitrate + Nitrite	Nutrient	mg/L		100
Nitrite	Nutrient	mg/L		10
Phenol	Trace Organic	µg/L		2
Phenoxy herbicides	Pesticide	µg/L		100
Picloram	Pesticide	µg/L		190
Selenium	Metal	µg/L	20 - 50[13]	50
Simazine	Pesticide	µg/L	0.5	10
Sulphate	Ions and General	mg/L		1000
Tebuthiuron	Pesticide	µg/L	0.27 (cereals)	130
Toluene	Trace Organic	µg/L		24
Total Dissolved Solids (TDS)	Ions and General	mg/L	500 – 3500[14]	3000

[11] Guidelines can serve as action levels or interim management objectives towards virtual elimination.
[12] Molybdenum guideline: 50 µg/L for short-term use on acidic soils.
[13] Selenium guideline: 20 µg/L for continuous use and 50 µg/L for intermittent use.
[14] Total dissolved solids guideline:

500 mg/L for:	strawberries, raspberries, beans and carrots;
500-800 mg/L for:	boysenberries, currants, blackberries, gooseberries, plums, grapes, apricots, peaches, pears, cherries, apples, onions, parsnips, radishes, peas, pumpkins, lettuce, peppers, muskmelons, sweet potatoes, sweet corn, potatoes, celery, cabbage, kohlrabi, cauliflower, cowpeas, broadbeans, flax, sunflowers and corn;
800-1500 mg/L for:	spinach, cantaloupes, cucumbers, tomatoes, squash, brussel sprouts, broccoli, turnips, smooth brome, alfalfa, big trefoil, beardless wildrye, vetch, timothy and crested wheat grass;
1500-2500 mg/L for:	beets, zucchini, rape, sorghum, oat hay, wheat hay, mountain brome, tall fescue, sweet clover, reed canary grass, birdsfoot trefoil and perennial ryegrass;
3500 mg/L for:	asparagus, soybeans, safflower, oats, rye, wheat, sugar beets, barley, barley hay and tall wheat grass.

TABLE 2.0 WATER QUALITY GUIDELINES FOR AGRICULTURAL USES (CCME 1999)

SUBSTANCE OR CONDITION	CATEGORY	UNIT	IRRIGATION WATER	LIVESTOCK WATER
Toxaphene	Pesticide	µg/L		5[4,5]
Triallate	Pesticide	µg/L		230
Tributyltin	Trace Organic	µg/L		250
Trichloroethylene (1,1,2-trichloroethene)	Trace Organic	µg/L		50
Tricyclohexyltin	Trace Organic	µg/L		250
Trifluralin	Pesticide	µg/L		45
Triphenyltin	Trace Organic	µg/L		820
Uranium	Metal	µg/L	10	200
Vanadium	Metal	µg/L	100	100
Zinc	Metal	µg/L	1000 to 5000[15]	50 000

[15] CEQG irrigation guideline for zinc: 1000 µg/L when soil pH < 6.5; 5000 µg/L when soil pH > 6.5.

TABLE 3.0 WATER QUALITY GUIDELINES FOR RECREATION AND AESTHETICS

SUBSTANCE OR CONDITION	GUIDELINE AND SOURCE
Aesthetics	All water should be free from: - materials that will settle to form objectionable deposits; - floating debris, oil, scum, and other matter; - substances producing objectionable colour, odour, taste, or turbidity; and - substances and conditions or combinations thereof in concentrations that produce undesirable aquatic life (CCME 1999).
Aquatic plants	Bathers should avoid areas with rooted or floating plants; very dense growths could affect other activities such as boating and fishing (CCME 1999).
Chemical characteristics	Limits for chemicals have not been specified because of lack of data. Decision for use should be based on an environmental health assessment and the aesthetic quality. Dermal exposures to environmental contaminants has recently been reviewed by Moody and Chu (1995) (CCME 1999).
Clarity	The water should be sufficiently clear that a Secchi disc is visible at 1.2 m (CCME 1999).
***Escherichia coli* (fecal coliforms)**	The geometric mean of at least five samples taken during a period not to exceed 30 d should not exceed 200 *E. coli* per 100 mL. Resampling should be performed when any sample exceeds 400 *E. coli* per 100 mL. See Health and Welfare Canada (1992) for additional information (CCME 1999).
Coliform bacteria	In waters to be withdrawn for treatment and distribution as a potable supply or used for outdoor recreation other than direct contact, at least 90 percent of the samples (not less than five samples in any consecutive 30-day period) should have a total coliform count of less than 5000 organisms per 100 mL and a fecal coliform count of less than 1000 organisms per 100 mL. For direct contact recreation, the geometric mean of not less than five samples taken over not more than a 30-day period should not exceed 1000 organisms per 100 mL for total coliforms, nor 200 organisms per 100 mL for fecal coliforms, nor exceed these numbers in more than 20 percent of the samples examined during any month, nor exceed 2400 organisms per 100 mL total coliforms on any day (AEP 1993).
Coliphages	Limits on coliphages cannot be specified at this time. See Health and Welfare Canada (1992) for additional information (CCME 1999).
Colour	Not to be increased more than 30 colour units above natural value (AEP 1993).
Cyanobacteria (blue-green algae)	Limits have not been specified. Health Canada is in the process of developing a numerical guideline for microcystin, a cyanobacterial toxin. Water with blue-green surface scum should be avoided because of reduced clarity and possible presence of toxins (CCME 1999).
Enterococci	The geometric mean of at least five samples taken during a period not to exceed 30 days should not exceed 35 enterococci per 100 mL. Resampling should be performed when any sample exceeds 70 enterococci per 100 mL. (CCME 1999). See Health and Welfare Canada (1992) for additional information on application of guideline (CCME 1999).
Nuisance organisms	Bathing areas should be free as possible from nuisance organisms that: - endanger the health and physical comfort of users; or - render the area unusable. Common examples include biting and nonbiting insects and poisonous organisms (CCME 1999).
Odour	The cold (20°C) threshold odour number not to exceed 8 (AEP 1993).
Oil and Grease	Substantially absent, no iridescent sheen (AEP 1993). Oil or petrochemicals not present in concentrations that: - can be detected as visible film, sheen or discolouration; - can be detected by odour; - can form deposits on shorelines and bottom deposits that are detectable by sight and odour (CCME 1999).
pH	When the buffering capacity of the water is very low, 6.5 to 8.5; range of 5.0 to 9.0 is acceptable (CCME 1999).

TABLE 3.0 WATER QUALITY GUIDELINES FOR RECREATION AND AESTHETICS

SUBSTANCE OR CONDITION	GUIDELINE AND SOURCE
Temperature	The thermal characteristics of water should not cause an appreciable increase or decrease in deep body temperature of bathers and swimmers (CCME 1999).
Turbidity	The turbidity of the water should not be increased more than 5.0 NTU over natural turbidity when turbidity is low (<50 NTU) (CCME 1999).
Waterborne Pathogens	The pathogens most frequently responsible for diseases associated with recreational water use are described in Health and Welfare Canada (1992), i.e. *Pseudomonas aeruginosa, Staphylococcus aureus, Salmonella, Shigella, Aeromonas, Campylobacter jejuni, Legionella,* human enteric viruses, *Giardia lamblia,* and *Cryptosporidium* (CCME 1999).

4.0 REFERENCES

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